# REAR SUSPENSION SYSTEM FOR BICYCLES

## CROSS REFERENCE TO RELATED APPLICATIONS

This is a Continuation of application Ser. No. 13/158,238, filed Jun. 10, 2011, which is a divisional of application Ser. No. 12/046,303, filed Mar. 11, 2008, now U.S. Pat. No. 7,980,579, issued Jul. 19, 2011, which is a continuation of application Ser. No. 11/008,260, filed Dec. 10, 2004, now U.S. Pat. No. 7,467,803, issued Dec. 23, 2008, which claims the benefit of the filing date of U.S. Provisional Application No. 60/528,725, filed Dec. 12, 2003. The disclosure of each of the previously referenced U.S. patent applications and patents (if applicable) is hereby incorporated by reference in its entirety.

## TECHNICAL FIELD

This application relates to an improved rear suspension system for bicycles.

## BACKGROUND

High-end mountain bikes typically have both rear and front suspension systems to assist in traversing uneven terrain. This is particularly the case for freeride, downhill and trail bikes which are designed to descend steep and uneven mountain terrain, often at high speeds. Many rear suspension systems designed for freeriding and other biking applications are known in the prior art. Such systems generally include a rear suspension permitting a limited degree of travel of the rear wheel relative to the bicycle frame and a rear shock absorber for absorbing suspension forces. The range of rear wheel travel that is permitted by existing suspension systems varies, but is typically within the range of about 5 to 12 inches measured vertically (although some designs permit travel outside this range).

While many mid and long rear wheel travel bicycle designs are known, most designs have rear suspension systems which compromise overall bike performance and versatility. Two primary problems caused by existing designs are (a) undesirable contact between the rear tire or suspension linkages and the bicycle seat or seat tube when the rear suspension system is under full compression; and (b) a restricted range of adjustability of the seat position.

U.S. Pat. Nos. 5,509,679, 5,678,837 and 5,899,480 owned by Specialized Bicycle Components, Inc. of Morgan Hill, Calif. describe two primary types of four bar linkage rear suspension systems, commonly referred to as the walking beam and low linkage designs. The above-noted patents are incorporated herein by reference in their entireties. The walking beam design is illustrated in FIG. **1** and includes a rocker arm link extending in a near horizontal orientation and a rear shock absorber having a travel axis extending in a near vertical orientation. The rocker arm link pivots on the seat tube portion of the bicycle frame and extends between an upper end of the rear shock absorber and an upper end of the seat stays. The main manufacturing advantages of the walking beam design are that the frame of the bike can be built out of a typical "triangle" shape, common in the bicycle industry, the pivot point for the rocker arm link can be conveniently arranged to mount to the seat tube, and the rear shock can be conveniently pivotally connected to the top of the bottom bracket area. The main performance advantage of the walking beam design is that the seat tube is straight and



continuous and allows for a full adjustment range of the seat (i.e., saddle) height. This is important because the seat needs to be raised to the correct biomechanical position to allow for effective pedaling performance when climbing up hills and crossing non-technical terrain and the seat needs to be lowered substantially (typically by 4 to 8 inches or more depending upon the rider's height and body proportions) so that the rider can safely and effectively traverse difficult or challenging terrain and obstacles.

The walking beam design is suitable for bicycle suspension frames with up to approximately 6 inches of vertical rear wheel travel. However, as the rear travel gets longer than about 6 inches, several problems arise with the walking beam design. As the rear wheel travel path starts to come forwards, towards the front of the bike, this movement combined with the generally rearward sloping seat tube causes the rear wheel and the seat tube to collide before the rear wheel has finished its travel. Further, the relatively high linkage arrangement (when compared to the low linkage four bar design described below) causes the rocker arm link (when the rear suspension is under substantial or full compression) to interfere with the low rearward position of the rider's "bottom" (a position needed to ride challenging terrain) and also the rear seat when the seat is lowered.

Longer travel suspension frames work better with rear shock absorber stroke length ratios that match their travel. If the ratio of rear wheel travel versus shock stroke length increases beyond a favourable ratio, then the relatively short stroke shock absorber will be less effective in its ability to control the movement of the rear suspension and will be potentially more prone to failure. Additionally, higher rear shock absorber spring rates are required, which reduces the "suppleness" of the rear suspension's feel. As the rear wheel's travel increases, the rocker arm link pivot must also be moved up "higher" along the seat tube, to accommodate the longer stroke rear shock absorber (which is fixed near the bottom bracket of the front triangular frame as shown in FIG. **1**). Additionally, the rocker arm link needs to be longer to accommodate the greater length of the shock absorber stroke. This exacerbates the problems discussed above concerning the interference of the rear wheel and rocker arm link with the frame's seat tube, seat, and the rider's bottom. These effects are increased even more in the case of smaller frame sizes designed for smaller riders, because there is less room for the suspension elements to move due to a seat that is in an overall lower position (because the rider is smaller).

Low linkage four bar rear suspensions as exemplified by the Specialized FSR design shown in FIG. **2** also exhibit several limitations. On the one hand, such low linkage designs do not suffer from rear wheel and rocker arm link interference issues as described above in connection with the walking beam configuration. This is because the rocker arm link is typically mounted in a lower, diagonal to near vertical position, and the rear shock absorber is mounted in a diagonal to near horizontal position (FIG. **2**). Additionally, the seat tube position can be arbitrary, as it is typically mounted to the end of a cantilevered "beam", instead of being welded in line with the bottom bracket axis. However, on the other hand the low linkage design requires that the rear shock "interrupt" the seat tube and hence causes the seat tube to be cut off at the shock absorber location. This severely limits the range of seat and seat post adjustability. This is a major problem on bikes designed for technical riding where the seat needs to be substantially lowered so that it is out of the way of the rider's body movement, such as when traversing uneven downhill terrain. To get the seat low enough, technical riders typically cut their seat post to